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ABSTRACT

As a part of an overall study of large-scale communications satellite systems for education, an estimate was made of the amount of money available for media-technology for the next five to fifteen years. Information was gathered on public educational expenditures in the United States. Public elementary and secondary school expenditures were related to income per capita and enrollment through a log-linear model. An equation was developed to predict expenditures for the years 1975, 1979, and 1985 for various population projections. Several curves were developed to give some indication of money which might be available for media-technology as a function of the pupil-teacher ratio. For 1975, it was predicted, from 3 to 6 billion dollars might be expected to be available for pupil-teacher ratios of 25 and 30 respectively. For 1985 there was considerably more spread in the various projections. The overall results of the study indicate that sizable funds might be available for media-technology in the time frame under consideration. It was noted however that further study and the effect of some court rulings which question the use of property taxes as the primary base for educational support may alter these predictions. (JY)

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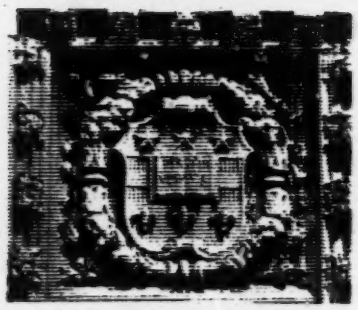

WASHINGTON UNIVERSITY

Memorandum No. 71-4

November, 1971

Public Education Finances: 1949 – 1985

Arthur Denzau

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PROGRAM ON APPLICATION OF COMMUNICATIONS SATELLITES
TO EDUCATIONAL DEVELOPMENT

WASHINGTON UNIVERSITY

Memorandum No. 71-4

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November, 1971

PUBLIC EDUCATION FINANCES:

1949 - 1985

Arthur Denzau

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SUMMARY

An investigation was undertaken which had as its main objective the development of estimates of budgets which might be available for media-technology in education for the next five to fifteen years. Some initial results of what will very likely prove to be a continuing study have been developed in this memorandum. This attempt to analyze public educational expenditures is part of an overall study of large-scale communications satellite systems for education being carried out at Washington University.

Information is presented on public educational expenditures in the United States. In 1949, the U.S. spent around $9 billion dollars for all of education, representing 3-1/2% of the Gross National Product (GNP). By 1967, these figures had grown to $57.5 billion dollars and more than 7% of GNP, respectively. This rapid growth seems very much tied to growth in both income and school enrollment.

Proceeding in a predictive and descriptive way, public elementary and secondary school expenditures have been related to income per capita and enrollment through a log-linear model. Data from previous years is used to derive the equation:

$$D_t = 0.337\ Y_t^{0.99845}\ (0.7\ E_t + S_t)^{1.5533}$$

where, D_t = current expenditures (billions of 1958 dollars),
Y_t = real personal income per capita (thousands of 1958 dollars),
E_t = K-8 enrollment (millions),
S_t = 9-12 enrollment (millions).

Income and enrollment elasticities of approximately 1.0 and 1.5 are therefore derived. This equation is then used as a predictor for the years 1975, 1979, and 1985 for various population projections.

Several curves have been developed to give some indication of money which might be available for media-technology as a function of the pupil-teacher ratio. For 1975 the results of the various projections all fall within a narrow range of values and from 3 to 6 billion dollars might be expected to be available for pupil-teacher ratios of 25 and 30 respectively. For 1985, there is considerable more spread in the various projections.

This study would seem to indicate that there might well be sizable funds available for media-technology in the time frame under consideration. However, the study is an initial attempt. Further work is required to examine the 1.5 enrollment elasticity factor and differences between this work and Office of Education expenditure predictions. A cross-sectional study approach is planned. It should also be kept in mind that the study assumes no major disruption in prior funding patterns. As this study was being carried out, court rulings in California and Minnesota have thrown into question the use of property taxes as the primary base for educational support. Hence, the risky business of prediction becomes even more risky. The whole area of public education financing is a fruitful one for future research.

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PUBLIC EDUCATION FINANCES: 1949-1985

SECTION I. INTRODUCTION

In 1949, the United States, at all levels, spent around $9 billion dollars for all of education. This represented 3½ percent of GNP (gross national product,see Table I.). By 1967, education had doubled its share to more than 7 percent of GNP and used $57.5 billions of resources (see Table 2). Growth of these magnitudes in a private industry would have been considered very unusual. In a country where private enterprise philosophy has deep roots, one would expect that such a huge, largely public industry would be challenged on many grounds, but particularly its consumption of such vast quantities of resources. In this memorandum, I shall attempt to examine the growth of this leviathan.*

Here, we examine only one part of this industry, Public Elementary and Secondary education (hereafter referred to as Public ES). This sector is one of the most important in the economy, since not only do almost all residents consume its products but also pay to support it. It has been viewed as the major means of upward social mobility for immigrants, etc. Recently, a so-called "taxpayer's revolt" has impacted this area, and some view Public ES as highly inefficient. Irregardless of this, it is true that its labor-intense production and apparent lack of productivity increase has and will cause a cost inflation. Private industry avoids this through substituting capital** for labor. This possibility is now open to Public ES by the use of Media-Technology. This has occurred almost involuntarily in some Roman Catholic parochial schools which have tried to use TV in their very large classes. It is the view of the author that the cost characteristics of this industry may eventually cause a drastic change toward the use of technology. Section 6 will describe one view of the possibilities for using Media-Technology in Public Elementary and Secondary education.

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*What follows should certainly not be considered a rigorous theoretical analysis. Rather, I consider it to be a descriptive and predictive attempt of positive economics. Most similar studies do not try to derive a rigorous, deductive model (1,9,10,11,12,13,21). Miner (13), however did derive a theoretical analysis of school board decisions. A recent article (22) utilized a deductive model of the voluntary exchange type. It is, in my opinion, quite flawed.

** Machines, equipment, automobiles,etc.

Table 1

Gross National product related to total expenditures[1] for education: United States, 1929-30 to 1969-70

Calendar year	Gross national product (in millions)	School year	Expenditures for education	
			Total (in thousands)	As a percent of gross national product
1	2	3	4	5
1929	$103,095	1929-30	$3,233,601	3.1
1931	75,820	1931-32	2,966,464	3.9
1933	55,601	1933-34	2,294,896	4.1
1935	72,247	1935-36	2,649,914	3.7
1937	90,446	1937-38	3,014,074	3.3
1939	90,494	1939-40	3,199,593	3.5
1941	124,540	1941-42	3,203,548	2.6
1943	191,592	1943-44	3,522,007	1.8
1945	212,010	1945-46	4,167,597	2.0
1947	231,323	1947-48	6,574,379	2.8
1949	256,484	1949-50	8,795,635	3.4
1951	328,404	1951-52	11,312,446	3.4
1953	364,593	1953-54	13,949,876	3.8
1955	397,960	1955-56	16,811,651	4.2
1957	441,134	1957-58	21,119,565	4.8
1959	483,650	1959-60	24,722,464	5.1
1961	520,109	1961-62	29,366,305	5.6
1963	590,503	1963-64	36,010,210	6.1
1965	684,884	1965-66	45,397,713	6.6
1967	793,544	1967-68	57,477,243	7.2
1969	932,100	1969-70	[2]69,500,000	7.5

[1] Includes expenditures of public and nonpublic schools at all levels of education (elementary, secondary, and higher education).

[2] Estimated.

Source: (Ref. 3, Table 25).

Table 2

Expenditures for education, including capital outlay, by level of instruction and by type of control: United States, 1967-68 (in thousands of dollars)

Expenditures, by level of instruction	Total	Publicly controlled	Privately controlled
1	2	3	4
All levels (elementary, secondary, higher)[1]	$57,477,243	$45,454,599	$12,022,644
Current expenditures (including interest)	49,161,350	38,903,821	10,257,529
Capital outlay or plant expansion	8,315,893	6,550,778	1,765,115
Elementary and secondary schools[2]	37,271,608	32,983,724	[3]4,287,884
Current expenditures (including interest)	32,462,564	28,727,933	[3]3,734,631
Capital outlay	4,809,044	[4]4,255,791	[3]553,253
Kindergarten through grade 8[5]	23,578,691	20,866,098	2,712,593
Grades 9-12 and postgraduate[5]	13,692,917	12,117,626	1,575,291
Other elementary and secondary schools[1]	300,000	200,000	100,000
Higher education (excluding subcollegiate departments)[6]	19,905,635	12,270,875	7,634,760
Current expenditures	16,398,786	9,975,888	6,422,898
Educational and general	13,108,420	8,137,659	4,970,761
Auxiliary enterprises	2,577,941	1,511,314	1,066,627
Student-aid expenditures	712,425	326,915	385,510
Expenditures from plant funds[7]	3,506,849	2,294,987	1,211,862

[1] Includes an estimate for "other" elementary and secondary schools such as residential schools for exceptional children, Federal schools for Indians, federally operated elementary and secondary schools on posts, and subcollegiate departments of institutions of higher education.

[2] Excludes expenditures for the "other" schools described in footnote 1.

[3] Estimated on the basis of expenditure per teacher in public elementary and secondary schools.

[4] Includes capital outlay of $169,146,168 by State and local schoolhousing authorities.

[5] Distribution between grade-groups (kindergarten-grade 8, grades 9-12 and postgraduate) estimated on the assumption that the cost per pupil in grades 9-12 is 50 percent higher than in grades K-8.

[6] Excludes schools of nursing not affiliated with colleges and universities.

[7] Excludes an estimated $668 million expended for plant expansion directly from current funds ($437 million by publicly controlled and $231 million by privately controlled institutions of higher education).

Source: (Ref. 3, Table 24).

Section 2. REVENUE

I shall analyze the revenue growth of public education* as being caused largely by three factors:

1) Income;
2) Enrollment: and
3) Costs of Secondary relative to Elementary school.

In utilizing these three, I have not exhausted every possible factor helping to determine the resources devoted to education. Some of these other factors are "environmental"; i.e., what are the financing resources, what are the legal powers of school boards, etc. These factors seldom change, and in a national perspective, do so only at a glacial rate. Other factors, related to the particular characteristics of a community, are relatively insignificant at a national level.** I will thus treat the three factors at more length, disregarding all others.

The first factor, income, seems quite understandable. As income increases, we would expect communities to spend part of that increase on public education.*** This indicates the expected direction, but does not tell how strong this relation is; i.e., as income increases, do education outlays go up faster or slower, and by how much? To describe this type of quantitative relation, we can use the elasticity concept.

An elasticity is a scalar that describes the relationship between two variables. In this particular case, the income elasticity is the percentage increase in expenditures that results when income goes up one percent.**** For example, if the elasticity is two, then that means that if income goes up at a one percent annual rate, revenues increase at two percent. One important aspect of elasticity is its relation to the share concept. On

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*The actual variable that will be explained (the dependent variable) is the level of current outlays for Public ES. This is exclusive of higher education.

**Another criterion, better understood after one reads Section 5, is that the determinants themselves must be predictable.

***There is, of course, the discussion of the problem of collective choice. That is, Public ES budgets are political decisions, and seem to be unrelated to the types of economic calculations carried out in private markets. I shall not be concerned with this problem here. Suffice it to say that there does exist some support in the economic literature for what I do. (References 22).

****This can be symbolized in difference notation (where Y = income, D = expenditures);

$$\text{Income elasticity} = \eta_{DY} = \frac{\Delta D}{D} \Big/ \frac{\Delta Y}{Y} ;$$

$$\text{or in differential calculus } \eta_{DY} = \frac{\partial D}{\partial Y} \frac{Y}{D}$$

Table 2, Column 5 is the percent of GNP going to education, i.e., education's share of GNP. If we assume that the income elasticity of revenues is one, then, that implies that income and revenue grow at the same rate. This implies that the share will remain constant. If the share does change, as it has between 1949 and 1969, then some other factors must have caused this. Since my empirical results (See Page 9) do yield an income elasticity of approximately one, these other factors must be important.

Enrollment, is the second factor used. Just as with income, as enrollment increases, I expect expenditures also to grow. The relationship can be described by an enrollment elasticity. This elasticity is closely related to the production relation between inputs and outputs. Starting from a relatively expensive one- or two-room school operation, enrollment can expand sizeably while costs rise less rapidly. Thus over some range, I would expect the enrollment elasticity to be less than one. Indeed, unless sizeable inefficiencies result at some point, this elasticity should not be much larger than one at any point. (This is the cause of my concern later when our derived elasticity is around 1.5.)

The fact that enrollment grows would be itself imply a growth of spending. But I have not yet specified the composition of that enrollment, e.g., has high school enrollment grown with elementary constant? This question of the relative impact on costs of enrollment composition is the third explanatory factor. The easiest explanation of this is a symbolic one:

Let N = enrollment;

S = secondary (grades 9-12) enrollment; and

E = elementary (grades K-8 enrollment.

Then it is clearly true that

$$N = S + E.$$

Thus, to use enrollment to help explain Public ES revenues, one would apparently just sum the public elementary and secondary enrollments. This, however, would disregard the relative cost factor; with the above formulation, as a student goes from elementary to secondary school (or as a million students do so), there would be no implied enrollment pressure on costs. To rectify this, I have used a weighted enrollment, N^1. A multiplicative factor, k, is used to represent the cost of an elementary student relative to a secondary one. (For example, if unit costs in elementary education are \$600, and in secondary, \$1000; then $k = \frac{\$\ 600}{\$1000} = .6$.) I then weight elementary enrollment by k to obtain

$$N^1 = kE + S.$$

For the statistical analysis, I computed a value for k (k = .70). This figure represented the relative per pupil teacher costs over the period (1949-69). Other values were tried and the results were found to be insensitive to this specification.

The rest of this section should be considered a lengthy footnote and can profitably be ignored by the casual reader. I wish to state more formally the model described above. Also, I need to relate the variables to the empirical data actually used. First, we need some notation.

D_t = demand for Public ES expenditures at time t;

Y_t = income per capita at time t;

N_t = enrollment at time t;

E_t = elementary (K-8) enrollment at time t;

S_t = secondary (grades 9-12) enrollment at time t; and

k = elementary unit cost (in units of secondary costs).

$$D_t = f(Y_t, N_t) \qquad (1)$$

$$f_1 > 0 \quad f_2 > 0$$

Equation (1) expresses more formally what was stated above; i.e., demand for education (measured by expenditures) is a function of income and enrollment, and moreover, is related positively to these two factors. The third factor enters in when we remember that

$$N_t = kE_t + S_t. \qquad (2)$$

The k factor could be either estimated beforehand or might be varied so as to obtain the best statistical fit.

$$\eta_{D,Y} = f_1 \frac{Y}{D}, \text{ where } \eta_{D,Y} \text{ is the income elasticity of Public ES expenditure.} \qquad (3)$$

Equation (3) uses the income elasticity discussed above. In a parallel fashion we can define the enrollment elasticity:

$$\eta_{D,N} = f_2 \frac{N}{D}. \qquad (4)$$

The actual model which I have estimated is a log-linear one. Symbolically this would be

$$D_t = \beta_o (Y_t)^{\beta_1} (kE_t + S_t)^{\beta_2} \qquad (5)$$

The interpretation of coefficients β_1, β_2 is simple: β_1 is the income elasticity, and β_2 the enrollment elasticity.

I will now discuss the particular empirical data to which I will link the above symbols. The D_t variable on the left side of the equation will be replaced by current outlays for public ES. This figure includes only actual spending. It excludes capital charges. Additionally, it is not in per-pupil terms as in most other such work. Expenditures are in real or constant dollar terms (1958 dollars). This is an attempt to remove inflation from the figures and thus give the "real" value of these expenditures in terms of other personal goods and services. Normally, one would attempt to use a deflation index specialized to the sector involved. In this instance, however, teacher compensation takes up nearly 60 percent* of the budget. If one divided D_t by average teacher salary, one would get a set of numbers proportional to the number of teachers hired. To avoid the dominating effect of teachers' pay, I have not tried to use any such specialized price index.

The Y_t variable is represented by personal income per capita. One uses personal income, which is essentially a before-tax measure, and not disposable personal income (which is net or after-taxes) because school expenditures are financed by taxes, and in our discussion above, we assumed that school taxes could be changed just as personal outlays. Thus the larger measure of income is more relevant. This variable is also put in real terms by dividing by the GNP personal expenditures price deflator.

Section 3. EXPENDITURES FOR EDUCATIONAL SERVICES

Here, I will discuss public ES purchase of inputs. We shall consider only actual cash outlays, neglecting the opportunity cost of student time as irrelevant to our present purposes. Also, we shall here consider only operating outlays, neglecting construction costs and interest on bonded indebtedness. Capital outlays are very sensitive to changes in numbers of students as opposed to levels, and are thus not homogeneous with the current costs. Table 3 shows some of these data in concise form.

The second column of Table 3, teacher compensation, there, was constructed as follows. First, I multiplied average classroom teacher salary figures** by the number of teachers. This, however, leaves out pension funds and retirement benefits which should also be included in their compensation; these are contained within the Fixed Charges component of HEW data.*** I added these fringe benefits to the salary total to derive teacher compensation figures.

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*See Section 4.

**In one case, 1949, classroom teacher salary estimates were not available. Instructional staff estimates were, however, and by reducing this by 3 percent, an often mentioned figure, I arrived at a mean salary.

***This has apparently gone unnoticed by most observers. Note Hirsch's handling (Ref. 9, p. 37), "Fixed charges . . . By definition these charges vary little with income."

Table 3

Public ES Expenditures, by categories
(Current dollars) in millions of dollars**

	Operating Expenditures of Public ES*	Teacher Compensation	Administration	Operation and Maintenance
1949-50	4,687	2,866	220	642
	100%	59.9%	4.7%	13.6%
1959-60	12,329	7,459	528	1,508
	100%	60.4%	4.3%	12.2%
1963-64	17,218	10,443	745	1,985
	100%	60.6%	4.3%	11.5%
1965-66	21,053	12,423	938	2,386
	100%	59.1%	4.5%	11.3%
1967-68	26,877	15,582	1,249	2,864
	100%	57.9%	4.6%	10.6%
1969-70	33,107	---	---	---
	100%			

*Does not include summer schools, adult education, community colleges, interest or debt outlays.

**Outlays other than the above 3 categories include Instruction (other than teacher salaries), Fixed Charges (other than teacher fringe benefits), and other school services. Thus these include textbooks, supplies, libraries, teachers' aides, insurance, busses, and lunchrooms. Source: (Ref. 3, Table 74).

As one can see from Table 3, few large share changes have occurred.* For this reason, I have considered it not totally unreasonable to project the total budget by means of my revenue equation and then to obtain a breakdown on the supply side by merely applying the share percentages for latest year available. While this ignores the input markets and possible dramatic changes (such as the hiring of 1 million teachers aides as recommended by Keyserling (11)), nevertheless, to attempt such things from present data is not possible here. Thus, I shall consider my figures as a benchmark.

However, we can consider changes in the education industry and examine their effect on the shares. This may not yield much more than impressions of future potentials. And in doing so one must always remember the inertia involved in such a system as public ES, with the implication that any change is slow and drastic changes difficult.

Section 4. EMPIRICAL RESULTS

Data concerning outlays, income, and enrollment were processed in a standard statistical fashion using multiple regression analysis.** By this technique, I derived estimates of our two key coefficients, the income and enrollment elasticities; these were as follows:

Income Elasticity = 0.99845; and

Enrollment Elasticity = 1.5533

The estimated equation was a quite good fit and the above coefficients very significant.***

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*The % drop noted in operation and maintenance can be attributed to several factors: a) the move to the Southwest (California), reducing fuel costs; b) newer buildings, allowing cheaper operation and less maintenance. This was suggested to me by Dr. Edward Greenberg.

**In particular, a log-linear model was assumed. The data was 11 observations on a biannual basis from 1949 to 1969.

***The estimated equation was

$$D_t = .0337\ Y_t^{0.99845}\ (.7E_t + S_t)^{1.5533} \qquad (6)$$

$$(6.257) \qquad (12.876)$$

$$N = 11 \qquad d.f. = 8 \qquad R^2 = 0.99813$$

The D_t, Y_t variables are in terms of 1958 dollars. (D_t is in billions, Y_t in thousands; E_t, S_t are in millions of enrolled pupils.

If we look at the income elasticity (.99845), we see that it is close to 1 and close to that found by Hirsch (1.09) in (Ref. 9). This seems not at all unreasonable and means that, all other things equal, education revenues have grown at the same rate as per capita income. Since I intend to use the above elasticities for predictions, let me rephrase this. Revenues will grow at the same rate as per capita income in the near future.* The other coefficient, however, is unusual, in that it is much greater than 1. One interpretation of this is that there exist diseconomies of scale in education; i.e., a one percent increase in enrollment causes a 1.55 percent increase in current expenditures. This interpretation certainly is erroneous. A more reasonable one is to remember that we have time-series data. Over the period 1949-1969, there has been, in some sense, declining labor productivity in the public schools. To be more explicit, the pupil-teacher ratio has decreased,** and this effect has been captured by my enrollment elasticity. Also, I believe, other effects of productivity, any scale factors, and other input changes all are being captured by this estimate.***

Additionally, there is a statistical problem that may have caused these results. If some of the explanatory factors are closely related, as are income and enrollment growth, then one may have what is called collinearity. It is well known that such can cause weight properly attached to one variable to be attributed to the other. To some extent, I believe that this has occured, causing the very high (1.5) enrollment elasticity estimate. On a priori grounds, this seems much too high (I believe it should be approximately 1.) If the regression had been run so that the enrollment elasticity were 1, then the resulting income elasticity would be 1.5. (This could result in my later predictions being biased downward by a 1/2% compound rate each year). This is important and I intend to pursue the analysis in a future paper using other data: this future work should allow me to refine the above elasticity estimates.

The increase in secondary as opposed to less expensive elementary school education is contained in the 0.70 factor multiplying the elementary (K-8) enrollment. As mentioned in the last section, the .7 was derived by computing the relative teacher costs of elementary and secondary education. Alternate values (from .60 to .75) were tried, and little change in the elasticities was noted. Also income per household was used with little effect on the estimates. Finally, an alternative definition of secondary enrollment was used. Those pupils below ninth grade but in junior high school were considered part of the secondary enrollment. This also had little effect on the parameter estimates.

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*Remember that a major purpose of this paper is to predict future finances of education. This will be accomplished by using the elasticities to relate future income and enrollment growth to future Public ES outlays. (The exact same thing is accomplished by plugging values of income and enrollment into Equation 6.)

**See Table A9. (Appendix)

***This causes no difficulty for our prediction if these factors remain associated with enrollment in the same way as in the past. To the extent that slowly growing or declining enrollments allow lower pupil-teacher ratios than the trend implies, my predictions of overall budgets will turn out lower than reality.

Section 5. PREDICTIONS AND ENROLLMENTS

I now will use the empirical results to generate predictions of our dependent variable, current expenditures. In order to do so, we need to use extimates of our independent variables (income per capita and enrollments). I will first discuss how this is done.

The real income per capita can potentially grow as rapidly as labor productivity. This occurs at approximately a 3 percent annual rate. At times, this growth does not occur (as at the present 1970-71 recession). However, past experience shows that the gap is typically made up. This means that several quarters after a recession bottoms out, actual income speeds up and catches the potential income line (at approximately 3 percent growth). This takes care of our first independent variable forecast. The second, enrollment, depends on three factors:

1) birth rates
2) retention rates, and
3) non-public enrollments

For the first and second factors, I will rely on the Census Bureau data and methodology. In concise terms, here is what they do. Child-bearing-aged women are grouped according to their birth date. Each such cohort contains women born in a five-year period; e.g., 1920-25, 1925-30, etc. For each cohort, a completed fertility rate is assumed. A completed fertility rate is the average number of children born to 1000 women during their total childbearing period. Four different assumptions are made, creating four series of projections (A,B,C,D). Table 4 gives some data on past cohorts and the completed fertility assumptions for each series. Series A assumes the continuation of the very high fertility of the 1925-30 and 1930-35 women who helped create the baby boom. I discard this series here as not likely. The others assume more reasonable rates.

The completed fertility assumptions do not tell us when these children are born, however. Another set of assumptions are made about this. Figure 1 illustrates this; on the vertical axis is the assumed age-specific birth rate. Since it is stated as a rate per 1000 women of a particular age, one can interpret it as a probability. In other words, a rate of 100 births per 1000 women at age 19 (Series D) means that, as an average $\frac{100}{1000} = .1$ or 10% of all 19 year old women will have a child. From these age-distributions can be derived estimates of total births. Figure 2 illustrates the various projections. This gives us the first factor needed to derive enrollment projections.

The second factor needed to forecast enrollments is the retention rate, which is also handled by assumption. Two different series are made by the Census Bureau.* Series I essentially projects 1950-65 trends in school

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*(Ref. 15 No. 365, p.2)

Table 4

Estimated and Assumed Completed Fertility Rates, for 5-Year Birth Cohorts of Women: Birth Years 1900-1905 to 1960-1965

(Average number of children born by end of childbearing period per 1,000 women. Rates below the heavy line are projections. Completed fertility rates for birth periods 1950-1955 and later correspond approximately (1950-1955) or exactly (1960-1965 and later) to the "terminal" rates in this report)

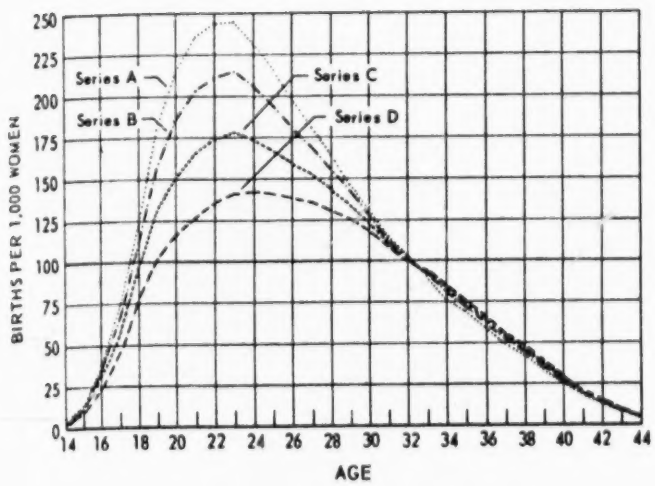
Birth period of women[1]	Age on July 1, 1965 (years)	Cumulative fertility rate to Jan. 1, 1966	Completed fertility rate			
			Series A	Series B	Series C	Series D
1900-1905	60 to 64	2,421	2,421	2,421	2,421	2,42
1905-1910	55 to 59	2,273	2,273	2,273	2,273	2,273
1910-1915	50 to 54	2,310	2,310	2,310	2,310	2,310
1915-1920	45 to 49	2,553	2,553	2,553	2,553	2,553
1920-1925	40 to 44	2,844	2,865	2,865	2,863	2,863
1925-1930	35 to 39	2,978	3,133	3,122	3,117	3,115
1930-1935	30 to 34	2,913	3,383	3,372	3,366	3,35
1935-1940	25 to 29	2,284	3,368	3,346	3,322	3,295
1940-1945	20 to 24	1,084	3,305	3,111	2,971	2,883
1945-1950	15 to 19	157	3,320	3,087	2,778	2,504
1950-1955	10 to 14	3	3,347	3,098	2,775	2,451
1955-1960	5 to 9	-	3,350	3,100	2,775	2,450
1960-1965	Under 5	-	3,350	3,100	2,775	2,450
1965 and later	(2)	-	3,350	3,100	2,775	2,450

- Represents zero.
[1]Period extends from July 1 of initial year to June 30 of terminal year.
[2]Born after July 1, 1965.

Source: (Ref. 15, No. 388, Table R).

Figure I

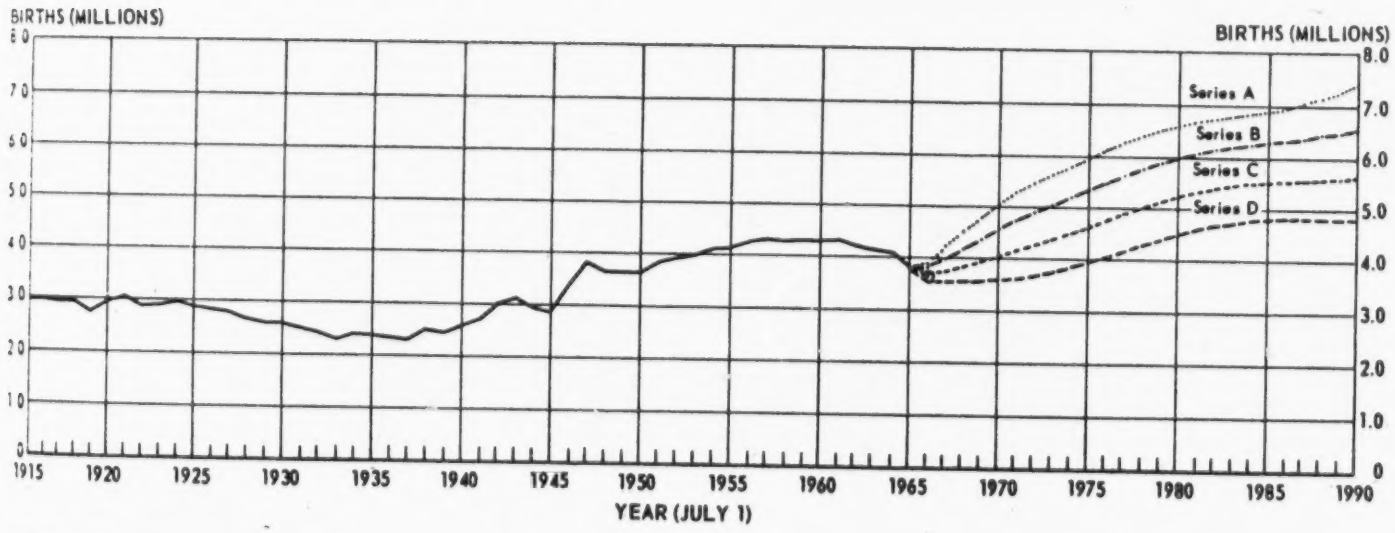
Distribution of Age-Specific Birth Rates Associated with Terminal Completed Fertility Rates



Source: (Ref. 15, No. 388, Figure 14).

Figure 2

Estimates and Projections of the Number of Births: 1915 to 1990



NOTE: POINTS RELATE TO CALENDAR YEARS.
● ESTIMATED FIGURE FOR 1966.

Source: (Ref. 15, No. 388, Figure 16).

retention linearly into the future. Series 2 is an average of Series 1 and 1965 data. Thus both assume gradually increasing participation, without drastic changes. These assumptions are applied to each fertility series; thus, we have 6 different school enrollment series, B-1, B-2, C-1, etc.

These two factors yield total school enrollments. The third factor is non-public enrollment. Table 5 presents a summary of historical data. As can be seen, no drastic changes are shown (this data does not show the effect of the newer "segregation academies" in the South). On this basis, a HEW projection in (2) foresees no change in grades 9-12 and a further drop of 200,000 in K-8 over two years. After that, no change is forecast. This implies non-public enrollments in 1975,'79,'85 to be:

K-8 - 4.1 million, and

9-12 - 1.4 million.

By subtracting these from my Census projections, I derive the public ES enrollments.** Some alternatives to this method are considered later and shown in Table 6. We now have the two independent variables and can generate projections for our dependent variable.

My basic estimates are generated in 1958 dollars using a D-1 population series. This is done quite simply by plugging the independent forecasts into the estimated Equation (6). Multiplying this by 1969-1970 consumer price index figure (1958 base) yields the estimates in terms of 1969-1970 dollars. This is presented in the first line of Table 7. On the second line is the Office of Education's projection from (Ref. 2, Table 42). These OE estimates are clearly lower than mine by 1979. This is, I believe, a result of their method of forecasting.*

A breakdown of the overall projection into teacher compensation and other is shown in Table 8. As suggested in the Expenditures section of this paper (and Table 3), I have assumed the teacher compensation share to remain at its 1967 level (57.9) percent). Public ES operating expenditures are depicted graphically in Figures 4 and 5 for various enrollment projections.

---

*They take a mean per pupil increment of a period (1959-64) and then add this amount to each successive year. This is neither an arithmetic growth nor exponential but, rather, a simple linear trend.

**See Figure 3.

Table 5

Non-Public Enrollments
(in millions)

	Total	K-8	9-12
1959	5.6	4.6	1.0
1960	5.9	4.8	1.1
1961	5.9	4.8	1.1
1962	6.1	4.9	1.2
1963	6.3	5.0	1.3
1964	6.3	5.0	1.3
1965	6.3	4.9	1.4
1966	6.3	4.9	1.4
1967	6.0	4.6	1.4
1968	5.8	4.4	1.4
1969	5.7	4.3	1.4

Source: (Ref. 2, Table 3).

Table 6

Alternative Results for
Non-Public Education

	Estimates of Public ES current outlays		
	1975	1979-80	1985
CASE 1			
Total (in billions of dollars)*	38.345	40.759	49.793
per student (in dollars)	865.24	952.58	1128.17
CASE 2			
Total (in billions of dollars)	45.428	48.627	59.746
per student (in dollars)	909.13	1008.34	1197.08

*all dollars are 1969-70 constant dollars.

Source: (Ref. 15, No. 365); this is for Projection D-1 estimates.

Table 7

Predictions of Public ES Operating Revenues, D-1

	1969*	1975	1979	1985
1) Basic projection (in billions of dollars) +	33.107	38.215	41.348	50.107
per student (in dollars)	710.27	851.71	965.51	1125.76
2) USOE (2) (in billions of dollars)	---	38.1	41.6	---
per student** (in dollars)	---	831.88	912.28	---
3) Enrollment (D-1) projection) (in millions)	46.610	44.569	42.825	44.510

Sources: (Ref. 2); enrollment from (Ref. 15, No. 365), and projection D-1, (Ref. 3).

*actual data (Ref. 3).

**enrollment projections in (Ref. 2).

+ all dollar figures are 1969-70 constant dollars.

Figure 3

Public ES Enrollment
(in millions)

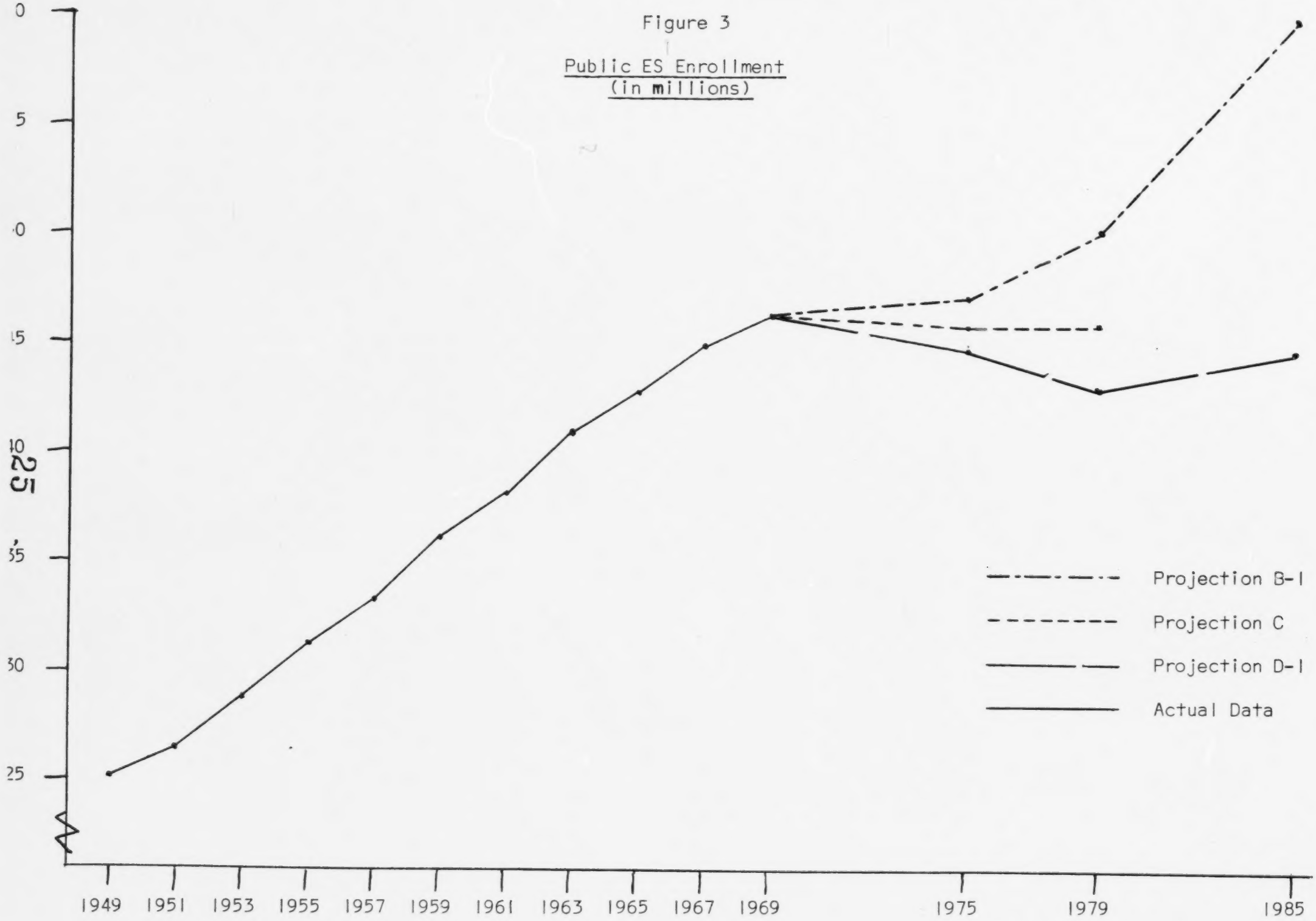


Table 8

Basic Projection, D-1, and Teacher Compensation
(constant 1969-70 dollars)

	1967	1975	1979	1985	Source
1) Basic projection of operating Expenditures (in billions)	26.877	38.215	41.348	50.107	line 1, Table 7; Table 3.
2) Teacher Compensation (in billions)	15.582	22.126	23.940	29.012	1) X .579.
3) Number of Teachers (in millions)	1.8552	2.079	2.089	2.2*	
4) Pupil-Teacher Ratio**	23.6	21.4	20.5	20.2	line 4, Table 7 ÷ 3)
5) Mean Teacher Compensation (in thousands)	8.399	10.643	11.460	13.187	2) ÷ 3)

Source: Teachers from (Ref. 2).

*own estimates.

**In enrollment terms, not ADA.

Figure 4

Public ES Operating Expendiutres
(in billions of 1969-70 dollars)

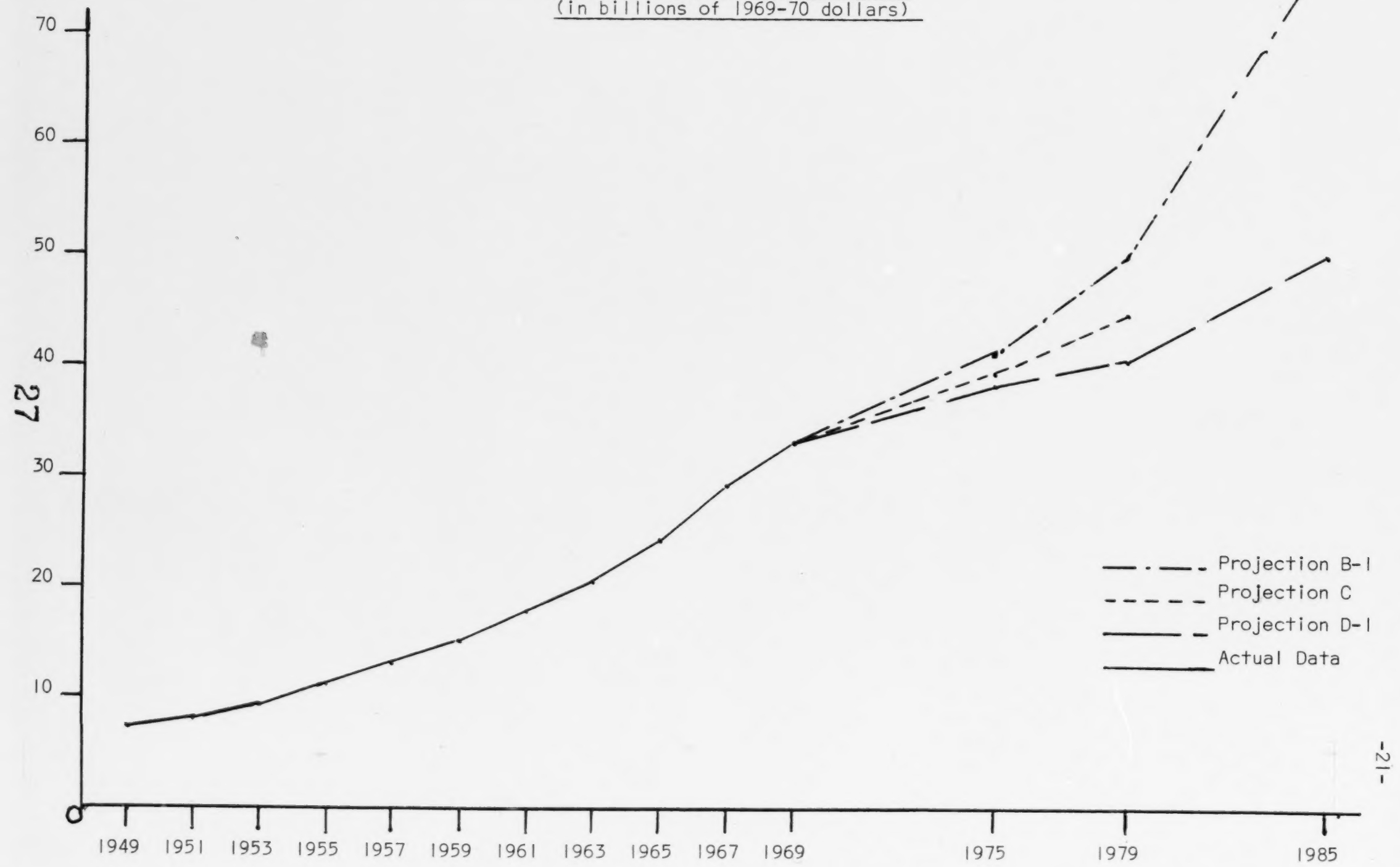
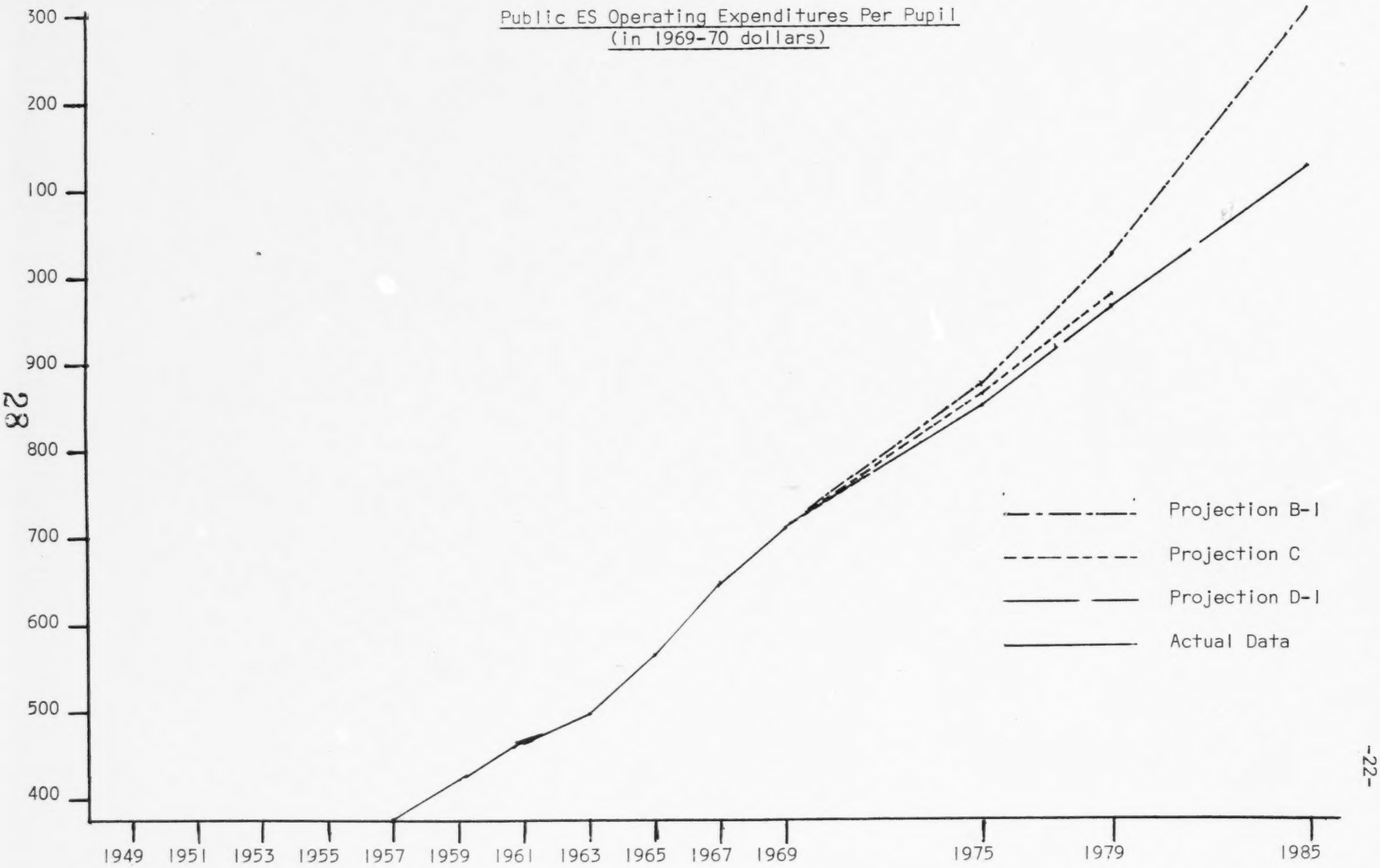


Figure 5

Public ES Operating Expenditures Per Pupil
(in 1969-70 dollars)



Section 6. A TENTATIVE ANALYSIS OF BUDGET CONSTRAINTS FOR MEDIA-TECHNOLOGY

In this section, I will use the above estimates of Public ES revenues and expenditure categories to analyze a particular problem. That problem concerns the availability of monies for a variety of media tools (among these might be multi-channel instructional television-ITV, video tape cassettes, computer assisted or computer managed instruction--CAI or CMI). The technique used will be described below. Some reasons for using it follow immediately.

As revenues grow, particularly per student revenues, a community (or other decision-making body) must decide how to allocate these funds, as well as judge whether past allocations were proper. We can assume that the decisionmakers prefer higher-quality education to lower, and they attempt to buy the types of inputs (teachers, books, etc.) that maximize this quality. In the past, as can be seen from the elementary pupil-teacher ratio on Table A9 (in the Appendix), a primary use of new funds has been lowering the pupil-teacher ratio. A second use has been increasing teacher salaries purportedly in order to get better teachers. In this section, we will consider a third possibility--that of putting funds into Media-Technology.

Thus, I shall present the empirical nature of this tradeoff, i.e., a change of X amount in the pupil-teacher ratio means how many bucks, both now and in the near future, for Media-Technology? This assumes that these resources can be made available by reordering priorities within education without channelling resources from other, noneducational programs. Of course, to the extent that such higher-level reordering takes place, both my overall budget estimate (Table 7) and the Media versus pupil-teacher ratio tradeoff will be erroneous. However, the general form of these tradeoffs will still exist, even if some outside money were introduced.

The present nature of the substitution possibilities are shown in Figure 6. On the horizontal axis is the Pupil-Teacher ratio (PTR) (in enrollment terms*). The vertical height then gives the money that could have been utilized for other purposes at that PTR. Thus, if the PTR had been 27, we would be at point B. This means that $2 billion would then have been available. Alternately, one can choose a budget amount on the vertical scale and find the implied PTR. In particular, if there were no substitution (no change from what then happened), then we would arrive at point A, a PTR of 23 to 24.**

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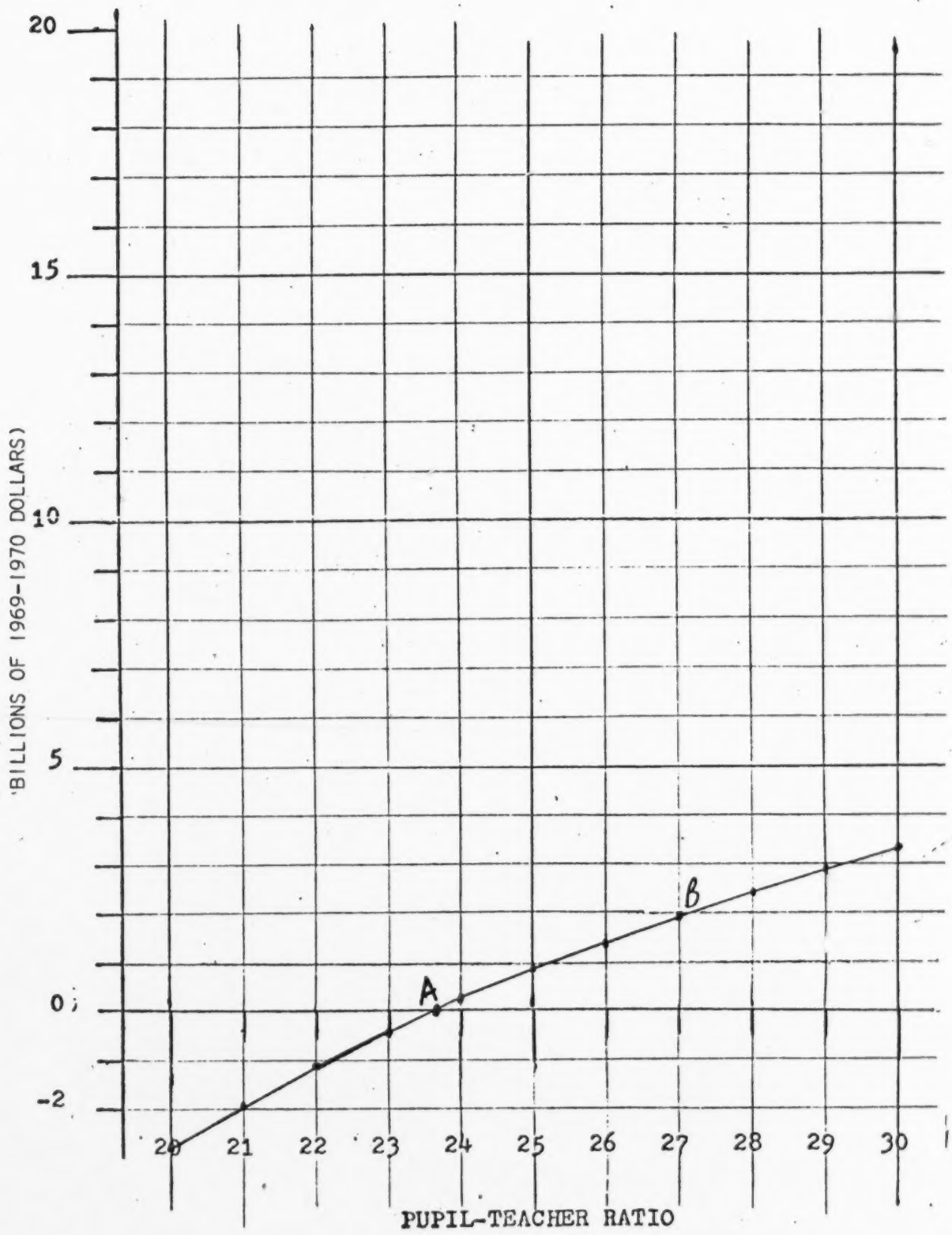
*In ADA terms, as the NEA prefers to report this statistic, these would be around 10% lower (20 would be 18, etc.). (ADA = Average Daily Attendance)

**The actual PTR in 1967 was 23.6.

Figure 6
BUDGET CONSTRAINT FOR MEDIA-TECHNOLOGY
(in billions of 1969-70 dollars)
versus PUPIL-TEACHER RATIO
1967



Now, in Figures 7-9, tradeoffs for 1975,1979 and 1985 are shown for each of the three population projections; B-1, C, and D-1. Those numbers were derived under the following assumptions:

1) The basic projection is accurate;
2) The proportion spent for other expenditures will remain at 1967 levels(42.1 percent); and
3) Mean teachers salaries will not change due to substituting media for teachers.*

The revenue potential according to these estimates definitely exists by 1979. The major question is whether decisionmakers will choose to make these substitutions. Clearly, given past indications and the problems of communications between educators and technolgists, a major shift is possible but not likely without well-publicized, successful demonstration projects in the uses of Media-Technology. Also, given that almost 20,000 decision-making bodies (school boards and legislatures) will make these decisions, the amounts available to each alone will be small. Thus they need to be shown projects which can be easily initiated, locally controlled, and yet coordinated with the uses in other locales in order to achieve economies of scale in such things as software production, etc. To solve these problems will take far more thought and analysis and is a separate issue from those considered here.

---

*I used the same salary figures for all estimates: the ones shown on line 5 of Table 8.

FIGURE 7
BUDGET CONSTRAINT FOR MEDIA-TECHNOLOGY
(IN BILLIONS OF 1969-70 DOLLARS)
VERSUS PUPIL-TEACHER RATIO FOR VARIOUS POPULATION PROJECTIONS
1975

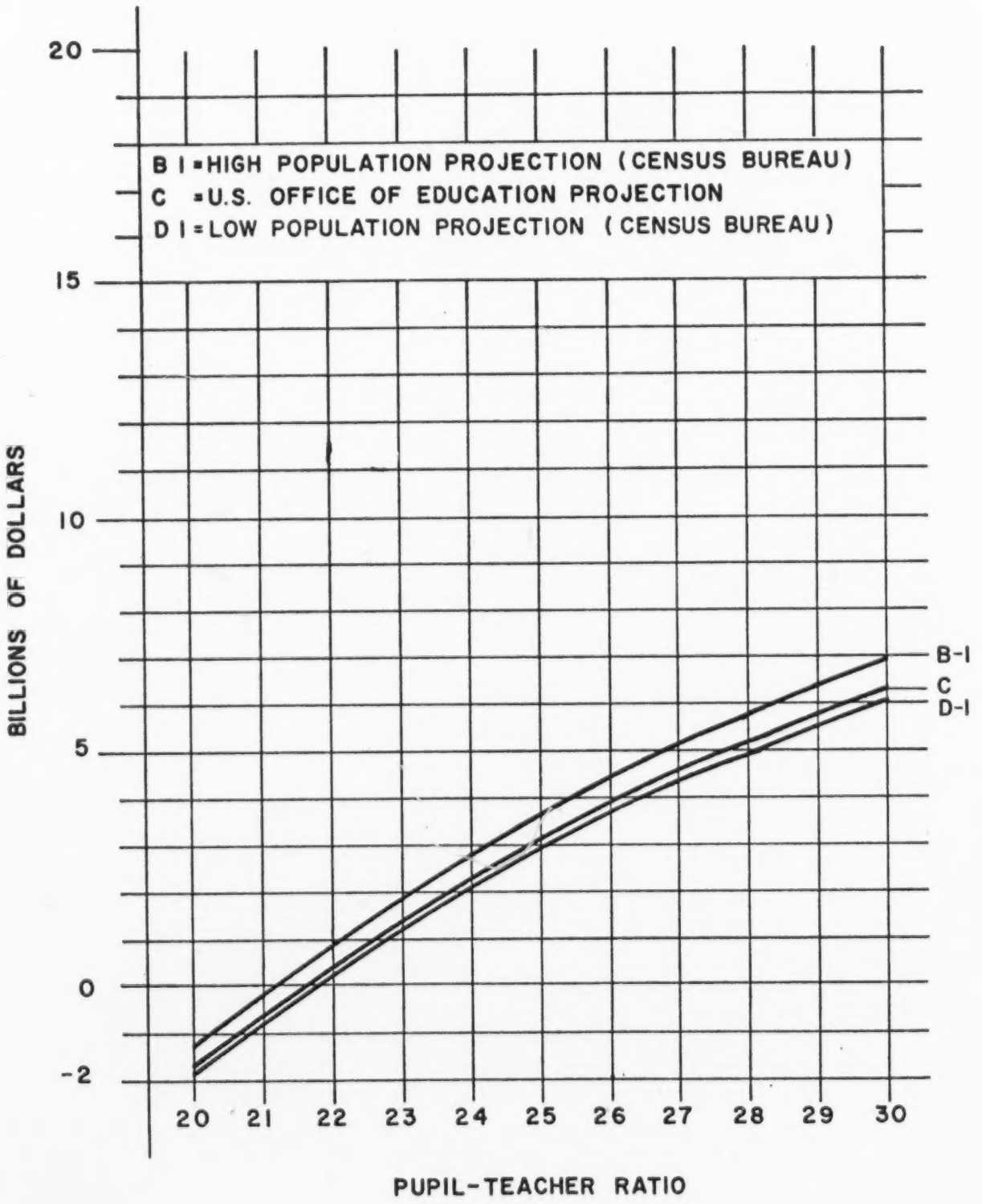


FIGURE 8

BUDGET CONSTRAINT FOR MEDIA TECHNOLOGY

(IN BILLIONS OF 1969-70 DOLLARS)

VERSUS PUPIL TEACHER RATIO FOR VARIOUS POPULATION PROJECTIONS

1979

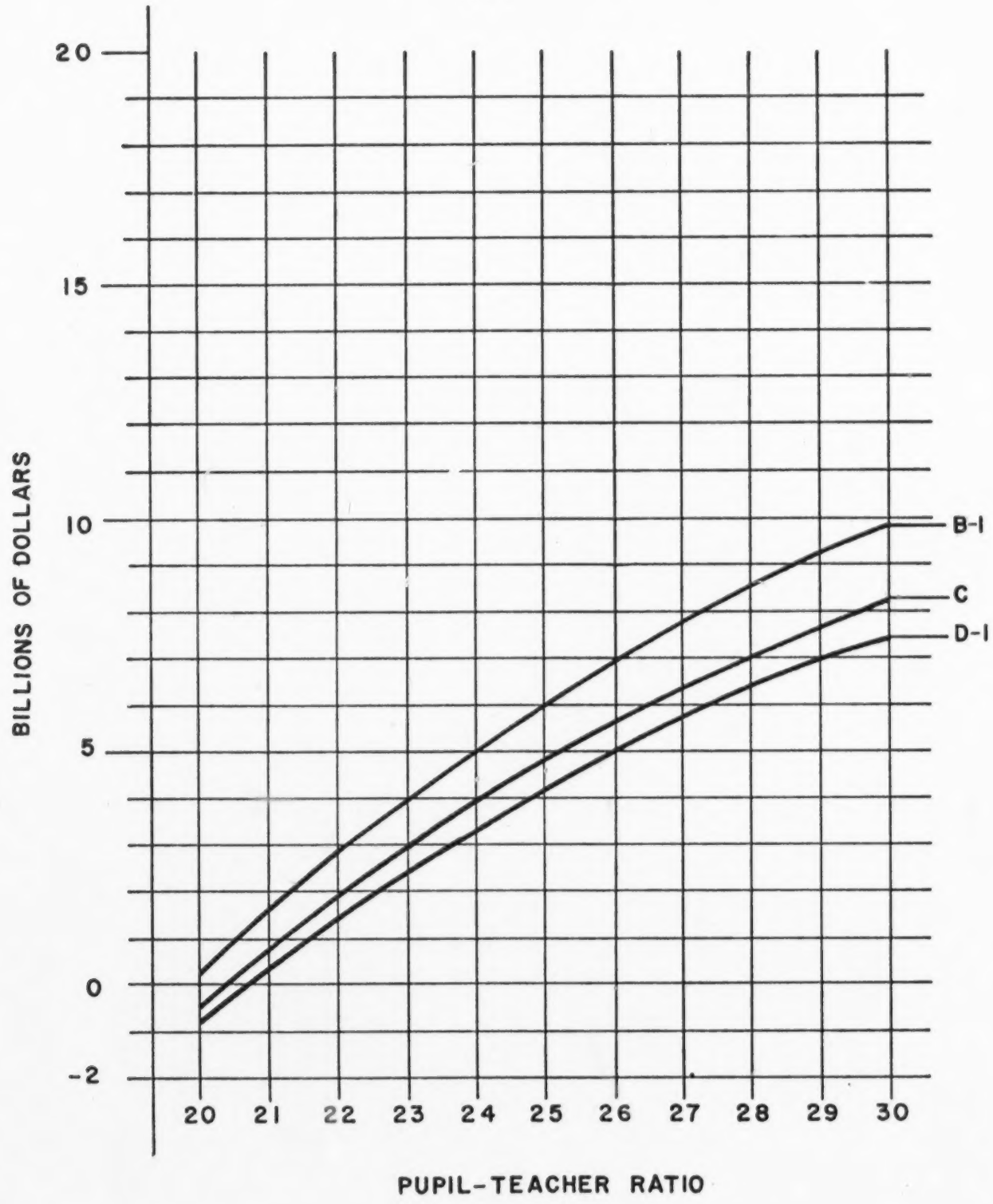
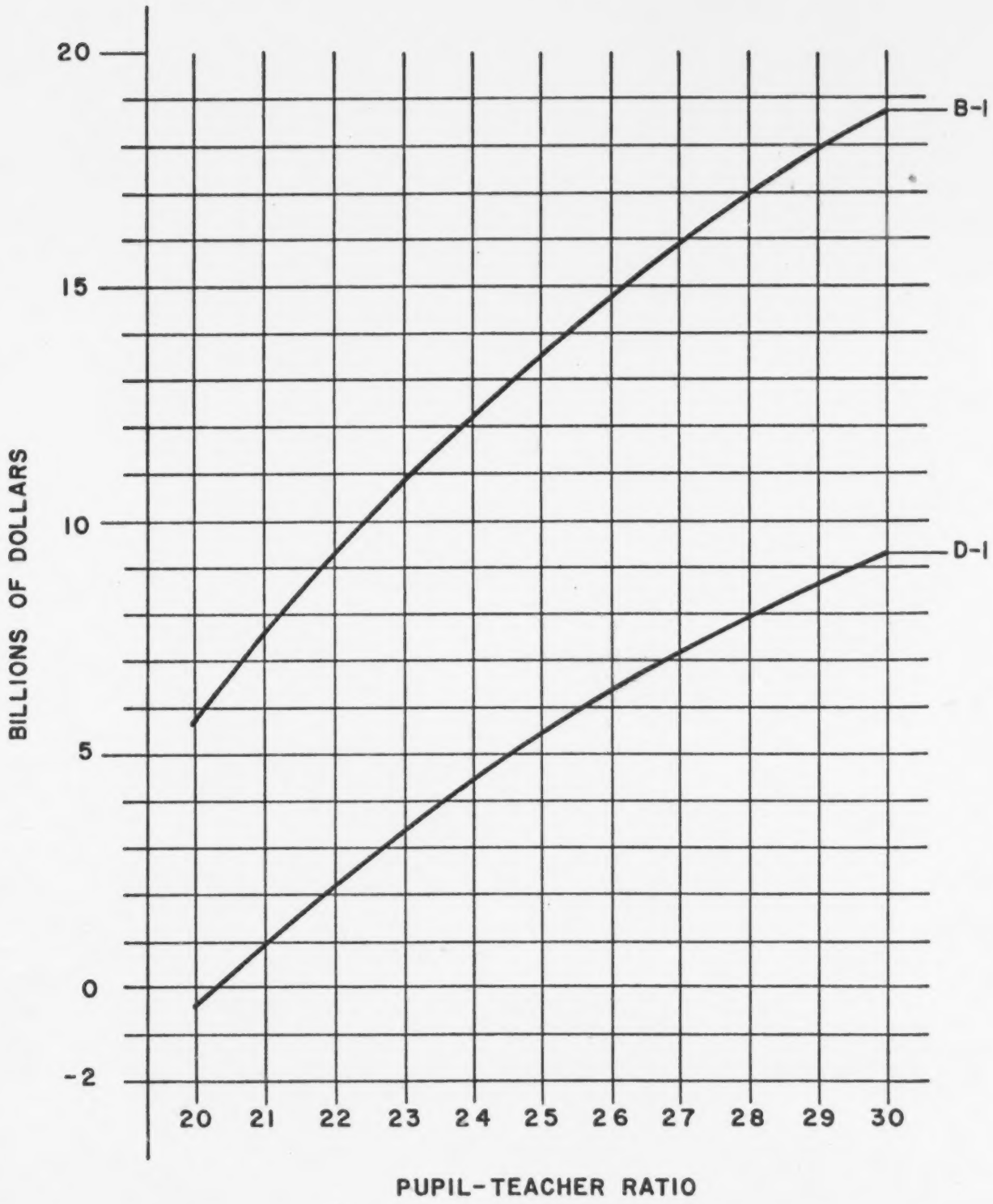


FIGURE 9
BUDGET CONSTRAINT FOR MEDIA TECHNOLOGY
(IN BILLIONS OF 1969-70 DOLLARS)
VERSUS PUPIL-TEACHER RATIO FOR VARIOUS POPULATION PROJECTIONS
1985



Section 7. THE NON-PUBLIC QUESTION

As stated above, I have used the HEW projections of non-public enrollments. Let us examine this more carefully. Table 5 shows some rounded-off estimates of past enrollments. The secondary school enrollment clearly shows no trend, and the HEW projection(2) is one of no further change. On the other hand, elementary enrollment has been trending down, and a recent Supreme Court decision (14), striking down Rhode Island and Pennsylvania non-public school aid schemes, gives further impetus to this. Countering this may be the segregation academies in the South. HEW's projection is continued drop of 100,000 a year for two more years. In Table 6, I present estimates similar to Table 8 but under two alternative assumptions concerning non-public enrollment:

Case 1. Non-public enrollment will remain at 13.4 percent of all elementary enrollment; secondary will remain at 7.0 percent. These are estimated 1970 levels.

Case 2. a) All non-public schools will close; or
b) Non-public per student expenditures will match the public schools and the budget projection includes both types of spending,public and non-public.

ACKNOWLEDGEMENTS

I wish to thank Professors Harold J. Barnett and Edward Greenberg for their patient aid and encouragement in the preparation of this paper. I also wish to express my gratitude to Dr. Robert P. Morgan, Director of the Center for Development Technology, for enabling me financially to continue this work.

APPENDIX A

Data Tables and Projections with Alternative Population Projections

Table A I

Total School Enrollment
Public and Non-Public
(in millions)

	1969*		1975		1979		1985	
	Elementary	Secondary	Elementary	Secondary	Elementary	Secondary	Elementary	Secondary
B-1	37.449	14.661	36.088	16.310	39.261	16.033	47.675	17.345
B-2	---	---	35.965	15.903	39.052	15.546	47.361	16.751
B	---	---	34.6	16.5	35.7	16.4	---	---
C	---	---	34.4	16.5	34.6	16.4	---	---
D-1	---	---	33.659	16.310	32.202	16.023	35.632	14.278
D-2	---	---	33.573	15.903	32.070	15.534	35.404	13.781
D	---	---	34.2	16.5	33.1	16.4	---	---

*Actual.

Sources: (Ref. 15, No. 365, Table 1); B, C, D projections are HEW's own figures from (Ref. 2).

Table A 2

Non-Public Enrollment
(in millions)

	Total	% of Public and Non-Public	Elementary	%	Secondary	%
1960	---	---	---	---	1.1	8.1%
1961	5.9	13.6%	4.8	16.8%	1.1	7.9%
1962	---	---	---	---	---	---
1963	---	---	---	---	1.3	8.3%
1964	---	---	---	---	1.3	7.9%
1965	6.3	13.0%	4.9	15.5%	1.4	8.3%
1966	---	---	---	---	---	---
1967	---	---	---	---	---	---
1968	---	---	---	---	---	---
1969	---	---	---	---	---	---
1970	5.6*	10.8%	4.2*	13.4%	1.4*	7.0%

*estimated; the rest is actual data.

Source: (Ref. 3, Tables 29, 39); (Ref. 2, Table 3).

Table A 3

Catholic Parochial School Enrollment
(in millions)

	Total	% of Non-Public	Elementary	%	Secondary	%
1965	5.481	87%	4.370	89%	1.111	81

Source: (Ref. 3, p. 36).

Table A 4

Basic Projections of Operating Revenues
(in millions of 1969-70 dollars)

Type of Population Projection	1969	1975	1979	1985
B-1	33,107	41,082	50,107	77,879
per student	710.27	874.12	1024.08	1306.25
B	---	39,637	45,962	----
per student	---	867.73	984.20	---
C	---	39,401	44,625	---
per student	---	865.96	978.62	---
D-1	---	38,215	41,348	50,107
per student	---	851.71	965.51	1125.76
D	---	39,166	42,516	---
per student	---	864.59	964.08	---

Source: (Ref. 2); (Ref. 15, No. 365).

Table A 5

Case 1* Projections
(in millions of 1969-70 dollars)

	1969	1975	1979	1985
B-1	33,107	41,525	48,914	74,048
per student	710.27	869.69	1000.07	1289.65
C	---	39,096	44,126	---
per student	---	866.19	975.90	---
D-1	---	38,345	40,759	49,793
per student	---	865.24	952.58	1128.17

*See p. 11 Bottom.

Source: (Ref. 2); (Ref. 15, 365).

Table A 6

Case 2* Projections
(in millions of 1969-70 dollars)

	1969	1975	1979	1985
B-1	33,107	48,473	58,663	89,070
per student	710.27	925.09	1060.93	1378.16
B	---	46,939	54,273	---
per student	---	918.58	1041.70	---
C	---	46,689	52,712	---
per student	---	917.27	1033.57	---
D-1	---	45,428	48,627	59,746
per student	---	909.13	1008.34	1197.08
D	---	46,439	50,611	---
per student	---	915.95	1022.44	---

*See p. 15 Top.

Source: (Ref. 2); (Ref. 15, No. 365).

Table A 7

Data

School Year	Current Expenditures (in billions of current dollars) (1)	Price Index (1958 = 100) (2)	Personal Income (in billions of 1958 dollars) (3)	Current Expenditures (in billions of 1969-70 dollars) (4)	Population July 1 (in millions) (5)	Households July 1 (in millions) (6)
1949-50	4.6873	81.5	262.4	7.36	147.58	42.498
1951-52	5.7222	89.6	294.1	8.09	154.88	44.648
1953-54	6.7909	92.3	312.6	9.31	160.18	46.341
1955-56	8.2514	93.5	345.2	11.2	165.93	48.108
1957-58	10.252	99.1	358.2	13.1	171.98	50.017
1959-60	12.329	102.2	384.8	15.2	177.83	52.002
1961-62	14.729	104.4	412.6	17.8	183.67	54.019
1963-64	17.218	106.7	449.6	20.4	189.20	55.901
1965-66	21.053	109.9	512.3	24.2	194.24	57.613
1967-68	26.877	116.3	564.3	29.2	198.63	59.831
1969-70	33.107	126.4	615.6	33.1	207.60	62.134

Table A 7 Continued

School Year	Elementary Enrollment (in millions) (7)	K-8 Enrollment (in millions) (8)	Secondary Enrollment (in millions) (9)	9-12 Enrollment (in millions) (10)
		Data		
1949-50	(18.149)	19.405	(6.963)	5.665
1950-51	---	19.900	---	5.780
1951-52	18.604	20.681	7.9580	5.851
1952-53	---	21.625	---	5.855
1953-54	(20.738)	22.546	(8.071)	6.263
1954-55	21.309	23.471	8.2169	6.559
1955-56	22.060	24.290	8.4725	6.860
1956-57	22.217	25.016	9.502	7.306
1957-58	22.280	25.669	10.054	7.841
1958-59	23.415	26.581	10.666	8.223
1959-60	23.906	27.602	11.276	8.481
1960-61	24.350	28.439	11.931	8.819
1961-62	24.603	28.686	12.861	9.559
1962-63	25.264	29.374	13.485	10.367
1963-64	25.776	29.915	14.412	11.104
1964-65	26.222	30.652	15.195	11.621
1965-66	26.670	31.177	15.504	11.653
1966-67	27.105	31.766	15.934	12.125
1967-68	27.372	32.495	16.519	12.565
1968-69	27.418	32.871	17.543	12.954
1969-70	27.455	33.249	18.163	13.261
1970-71	27.269	---	18.712	---

Sources and Notes for Table A 7

Figures in Table A 7 which are in parentheses are estimates.

Column 1: 1959-1969, 3); 1949-1957, (Ref. 4, 5, 6, 7, 8).

Column 2: GNP Implicit Price Deflator for Personal Expenditures; (Ref. 16, 17).

Column 3: (Ref. 16, 17).

Column 4: Column 1 inflated by Column 2.

Column 5: (Ref. 15, Nos. 25, 381).

Column 6: Exponential interpolation from data in (Ref. 15, No. 388).

Columns 7 & 9: 1949 figure from ADA in (4); 1953 from interpolation of 1951 data (5) and 1954 data (Ref. 18, No. 417); 1955, (Ref. 18, No. 467); 1956-57, (Ref. 18, No. 513); 1958-61, (19); 1962, (Ref. 18, No. 703); 1963, (Ref. 18, No. 735); 1964-65, (19); 1966-68, (2); 1969-70, (3).

Columns 8 & 10: 1949-57, (Ref. 4, 5, 6, 7, 8); 1958-69, (3, Table 28).

Table A 8

Data on Expenditures

(in billions of current dollars)

	Current	Administration	Plant Operation	Maintenance	Teacher Fringe Benefits (part of Fixed Charges)	Fixed Charges	Other
	(1)	(2)	(3)	(4)	(5A)	(5)	(6)
1949	4.6873	.22005	.42759	.21416	.19865	.26147	.45166
1951	5.7222	.26564	.50858	.24867	(.270)	.34160	.57584
1953	6.7909	.31100	.62267	.28487	(.352)	.44625	.57379
1955	8.2514	.37296	.75274	.31956	.38484	.53139	.77285
1957	10.252	.44333	.92434	.37813	.54355	.71503	.89012
1959	12.329	.52841	1.0850	.42259	(.6911)	.90932	1.0333
1961	14.729	.64837	1.2831	.47735	.82647	1.0773	1.2269
1963	17.218	.74477	1.4458	.53919	1.0430	1.3437	1.3945
1965	21.053	.93765	1.7627	.62358	(1.293)	1.7010	1.5829
1967	26.877	1.2490	2.0746	.78976	(1.815)	2.3883	1.9997

Sources: (Ref. 3, 4, 5, 6, 7, 8).

Table A 9

Data on Instructional Expenditures

	Total	Average Teacher Salary			Number of Teachers			Pupil-Teacher Ratio		Total Teacher Compensation			Instructional Staff Salaries Salaries	Clerical Assis-tance	Texts	Library	Supplies
		All	Elem.	Sec.	All	Elem.	Sec.	Elem.	Sec.	All	Elem.	Sec.					
1949	3.1123	2.920	---	---	913.67	589.58	324.09	30.78	21.49	2.6675	---	---	2.8965	30.538	48.076	7.866	129.37
1950	3.3930	---	---	---	---	---	---	---	---	---	---	---	3.1414	---	52.814	---	---
1951	3.4927	---	---	---	.96286	.61980	.34306	30.02	23.20	---	---	---	3492.7	56.473	53.473	12.956	166.01
1953	4.5523	---	---	---	1.0321	.65752	.37462	31.54	21.54	---	---	---	4.2005	71.877	72.660	18.645	188.63
1955	5.5019	4.055	3.852	4.409	1.1331	.72289	.41020	30.52	20.65	4.595	2.785	1.809	5.1031	85.980	75.626	20.417	216.78
1956	---	4.239	4.044	4.581	---	---	---	---	---	---	---	---	---	---	---	---	---
1957	6.9009	4.571	4.373	4.894	1.2378	.77832	.45953	29.27	21.88	5.658	3.404	2.249	6.3682	127.27	101.89	31.525	272.04
1958	---	4.797	4.607	5.113	---	---	---	---	---	---	---	---	---	---	---	---	---
1959	---	4.995	4815	5276	1.3550	.83377	.52119	28.67	21.64	6.768	4.015	2.750	7.4750	---	---	---	---
1960	---	5.275	5075	5543	---	---	---	---	---	---	---	---	---	---	---	---	---
1961	---	5.515	5340	5775	1.4580	.87731	.58066	28.04	22.15	8.041	4.685	3.353	---	---	---	---	---
1962	---	5.732	5560	5980	---	---	---	---	---	---	---	---	---	---	---	---	---
1963	11.750	5.995	5805	6266	1.5680	.90661	.66137	28.43	21.79	9.400	5.263	4.144	10.775	NA	175.80	92.000	NA
1964	---	6.195	5985	6451	---	---	---	---	---	---	---	---	---	---	---	---	---
1965	---	6.485	6279	6761	1.7163	.96764	.74865	27.56	20.71	11.130	6.076	5.062	---	---	---	---	---
1966	---	6.830	6622	7109	---	---	---	---	---	---	---	---	---	---	---	---	---
1967	18.376	7.423	7208	7692	1.8547	1.0402	18.454	26.31	20.28	13.767	7.511	6.265	---	---	---	---	---
1968	---	7.952	7718	8210	---	---	---	---	---	---	---	---	---	---	---	---	---
1969	---	8.560	8321	8843	2.0138	1.1078	.90606	24.78	20.05	17.238	9.218	8.012	---	---	---	---	---

Sources for Table A 9

Average Teacher Salary from (Ref. 20);

Pupil-Teacher Ratio from dividing data on enrollments from Table A 7 by Number of Teachers;

Total Teacher Compensation from multiplying Average Salary by Number of Teachers and adding Fringe Benefits (column 5A, Table A8;

All other data is from (Ref. 3, 4, 5, 6, 7, 8).

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